Structuring and preparation of a lesson: **EAS module 3 (Construction and design)**

time	Theme, core information, statements or questions	Learning objectives [1]	Methods (e.g. presentation/ discussion/group work)	Media/ training material
2,5h	<u>Fundamentals of strength of materials:</u> Different behaviors (elastic, elastic-plastic, plastic, viscoelastic, viscoplastic, elastomeric….). Behaviors of materials under different conditions of temperature and load Types of fracture	Identify the different types of mechanical behavior that materials can exhibit. (1) Summarize the different behaviors that a material can present under the influence of varied temperature and load conditions. (1) Categorize the different types of fracture that can occur when a joint fails. (2)	Demonstration of different behaviors with a metallic spring and/or plasticine. Demonstration and analysis of different fracture surfaces.	White board. Slides presentation. Demonstration objects (e.g. tested specimens with different types of fracture surfaces). Laboratory equipment to manufacture and test materials and adhesive joints.
4h	<u>Joint design:</u> Design principles (calculation of stress) Conditions of equilibrium	Summarize the different methods (analytical and numerical) used to predict the stress distribution in an adhesive joint under load. (1) Recall the conditions of equilibrium that enable the transfer of forces in an adhesive joint. (1)	Demonstration of calculation of stresses in bonded joints using analytical methods. Demonstration of calculation of stresses in bonded joints using a	White board. Slides presentation. Demonstration objects (e.g. bonded joints with different geometries). Laboratory equipment to manufacture and

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	Considerations about some physical concepts (stiffness, moments of inertia, etc.) Different types of stresses on bonded joints (tensile, shear, peel), multiaxial stresses and combined stresses) Stresses induced by differential straining (heterogeneous joints) Measurement of stresses in bonded joints Different types of bonded joints Classification of different types of bonded joints (lap, cylindrical and tubular joints) Tolerance requirements	Clarify physical concepts like stiffness and moments of inertia. (1) Identify the different types of stress that are present in an adhesive joint. Compare the effect of the different types of stresses on the strength of adhesive joints. (1) Illustrate how the use of heterogeneous materials in a joint can lead to differential straining which induces additional stresses. (1) List different methods to measure the stress value in bonded joints. (1) Identify what type of bonded joint is suitable for a given purpose. (1) Identify the different joint geometries. (1) Exemplify usual applications of the different joint geometries. (1) Design a joint able to respect given tolerance	numerical method (finite element method). Discussion about the types of bonded joints used in industrial applications. Discussion about the types of bonded joints produced in the practical course exercises. Practical demonstration (e.g. production and testing of joints with different geometries and/or different materials).	test adhesive joints.

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	Influencing factors (experimentally verified) Design proof testing	requirements (related to gap-filling ability of different types of adhesives). (2) List the different factors that can influence the performance of adhesive joints and explain how they change the performance of a joint. (1) Perform simple and quick tests that validate the design decisions before the final joint design is implemented. (2) Appraise all aspects of a given joint design project case study, such as defining the most suitable geometry, materials, selecting manufacturing parameters, identifying the major stresses acting upon the joint, checking tolerances and defining validation procedures. (2)		
1,5h	<u>Hybrid joints:</u> Adhesive bonding associated with riveting, spot welding, screwing, clinching, setting,	Name different types of hybrid joints. (1)	Discussion about practical examples of application of	White board. Slides presentation.

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	crimping, shrinking Advantages and limitations of hybrid joints Rules for design of hybrid joints Comparison of the performance of hybrid joints with bonded joints Influence factors Practical examples in industry	Recognise the advantages and limitations (e.g. production costs, equipment required for production, materials) of each type of hybrid joints when compared to bonded joints. (1) Outline the rules that should be considered for the design of the different types of hybrid joints. (1) Analyze the requirements of the rules related to the design to hybrid joints and transfer this knowledge to practical applications. (2) Explain the differences in performance (strength, durability) of each type of hybrid joint when compared to bonded joints. (1) Name the different factors that can influence the performance of a hybrid joint. (1)	hybrid joints, focusing on the type of hybrid joint chosen and the motivations behind the non-application of bonded joints. Practical demonstration (e.g. tensile tests of different hybrid joints).	Demonstration objects (e.g. different types of hybrid joints).

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		Summarize how each of these factors change the performance of a joint. (1) Provide practical examples where hybrid joints are commonly used rather than bonded joints. (2) Appraise the use of hybrid adhesive joints, checking their suitability for a given application and understanding the rules related to their design. (2)		

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